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FOOD HABITS OF JUVENILES OF SPOTTED SEATROUT AND GRAY SNAPPER IN WESTERN FLORIDA BAY

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ABSTRACT

Stomach contents were analyzed from 144 juvenile spotted seatrout, *Cynoscion nebulosus,* and 215 juvenile gray snapper, *Lutjanus griseus,* collected by trawl or rotenone from shallow seagrass flats, deep bank channels, or mangrove prop root habitats in western Florida Bay. Both species fed almost exclusively on crustaceans and fishes. Smaller non-decapod crustaceans—copepods, amphipods, and mysids—were more abundant as measured by percent occurrence in the smallest size classes (<50 mm SL). Penaeid shrimp, the most numerous prey in both fishes, and caridean shrimp increased in percent occurrence as fish increased in size. Fish were important in the largest size classes, above 150 mm SL. Rainwater killifish, *Lucania parva,* was the most common fish consumed. About 20% of the trout and snapper had empty stomachs when collected in grassflats, whereas about 60% of both species had empty stomachs when taken in channels. Relatively few fish were collected in mangroves and none of these specimens contained penaeids. No prey species were identified in either gamefish that are not common in Florida Bay.

Spotted seatrout, *Cynoscion nebulosus,* and gray snapper, *Lutjanus griseus,* are two of the four gamefish species most preferred by sport fishermen in Florida Bay. Florida Bay serves as both a nursery for the juveniles as well as a sportfishing ground for the adults of these two species (Rutherford et al., 1983). Information on feeding habits is important for understanding the life history of species whose juveniles and sub-adults occupy the same general habitat. In response to perceived declines in catch rates of spotted seatrout and gray snapper in recent years (Rutherford et al., 1982), additional research into the biology of those species was sponsored by the National Park Service. A trawl survey of central and western Florida Bay was conducted by the National Marine Fisheries Service to define the juvenile habitat of these and other fish species (Thayer and Chester, 1989). The stomach contents of all spotted seatrout and gray snapper collected were analyzed.

Food habits of spotted seatrout throughout their range in southeastern United States are well documented. Approximately 30 studies on feeding and food habits are cited by Mercer (1984). Although most of these studies are on adults, data on young fish (<200 mm) generally showed that feeding habits progressed through four stages (Rutherford et al., 1982). As the fish grew, the dominant food item changed from copepods to caridean shrimp to penaeid shrimp to fish.

Gray snapper food habits, particularly of adults, are also known. They, like spotted seatrout, prey mainly on crustaceans and fish and shift their diet from amphipods, shrimp and small crabs in grassbeds as juvenile fish to fish and larger crabs in channels and reefs as adults (Starck and Schroeder, 1970; Rutherford et al., 1983 and numerous references therein).

The purpose of this study was to compare the feeding habits of the juveniles of these two gamefishes collected from three habitats in Florida Bay—shallow grass flats, deeper bank channels, and mangroves during the year and to describe how prey species change with different size classes of juveniles.

MATERIALS AND METHODS

Collection stations, habitat descriptions and sampling protocol are described in detail by Thayer and Chester (1989). The analysis of stomach contents was incidental to the main purpose of the survey,

which was to assess the distribution and abundance of juvenile and forage fishes in various habitats. Specimens for stomach analysis were not iced or injected with preservative, but were treated the same as all other specimens in the survey. Most food habitat studies include percent by weight or volume analysis of food items. A relative importance index can also be derived by knowing the percent frequency of occurrence, percent number, and percent weight for each food item (George and Hadley, 1979). In my study, stomach volumes and gravimetric analysis did not seem appropriate because of a discouraging amount of decomposition of the stomach contents caused by delayed preservation as well as differential digestion associated with prey type (soft vs. hard body) and the interval between feeding and capture. Some particularly large catches of fish and seagrass took as long as an hour after capture to sort and preserve fish. During analysis, some stomachs contained freshly ingested shrimp or fish that could be readily identified, while in other stomachs, especially those captured later in the day, only remnants of harder body parts such as scales, vertebrae, carapace rostra and chelipeds could be recovered. Assuming that these gamefish prey largely on whole, live organisms, weights of the partial remains of well-digested prey would be meaningless.

Food habits of these species were evaluated by grouping juveniles into seven size classes: five are between 30–250 mm, one less than 30 mm and one greater than 250 mm standard length. Stomach contents of all spotted seatrout and gray snapper collected were identified to major groups of prey which included copepods, mysids, amphipods, isopods, decapod zoea/megalopa, carideans, penaeids, crabs, fish and vegetation. The number and size (maximum length) of each prey item in each stomach was noted, but data analysis was reduced to a comparison of the frequency of occurrence of each food group by fish size class and by habitat type. The frequency of occurrence was calculated as a percentage of the non-empty stomachs containing the food group.

Results and Discussion

Fish Distribution by Habitat and Season.—Spotted seatrout and gray snapper were collected during every month of the stratified sampling phase of the study (Thayer and Chester, 1989) (Table 1). The size class containing the largest abundance of trout and snapper was the 30–50 mm group and the 75–100 mm group, respectively. Only four fish (one trout, three snapper) larger than 250 mm SL were collected, probably due to gear avoidance. The greatest number of fish of each species were collected in September; collections in May 1984 and 1985 and June 1984 and 1985 are combined in Table 1.

Environmental parameters associated with these species were used to develop discriminant functions that describe characteristics of preferred habitat of juvenile trout and snapper (Thayer et al., 1987b). Prime juvenile spotted seatrout habitat occurred in western Florida Bay seagrass flats and in bank channels located in the western and southern portions of Florida Bay (Fig. 1). Gray snapper habitat appeared to be focused primarily in grass flats and channels located between Ninemile Bank and East Cape and in channels in the near vicinity of the Florida Keys.

The smallest juvenile trout (0.1 g·individual^{-1}) were taken in June from seagrass flats. Individuals collected in channel habitat always were larger than those collected in seagrass flats. More individuals were collected from mixed *Thalassia, Syringodium* and *Halodule* meadows having lush growth (1,000–4,000 shoots·m^{-2}) than from any single monotypic seagrass habitat (Thayer and Cheser, 1989). Snapper were most abundant in channels with mixtures of *Thalassia* and *Halodule,* and in non-channel habitats with mixtures of *Thalassia* and *Syringodium* or *Syringodium* and *Halodule.* The smallest snapper (0.5 g·individual^{-1}) were collected within mangrove prop roots.

Spotted Seatrout Stomach Contents.—Few trout were collected in channels or mangroves (Table 1) compared to seagrass beds. Fish appeared to be most important to trout in channels and mangroves. Penaeid shrimp were missing in the diet of the four trout collected in mangroves. From channels, smaller trout (<50 mm) contained copepods and penaeid shrimp, while the larger fish (100–150 mm) ate penaeids and fish. From mangroves, 30–100 mm fish ate mysids, amphipods,

Table 1. Numbers of spotted seatrout and gray snapper in each size class by month and habitat (May 1984 and 1985 and June 1984 and 1985 are combined)

Month; habitat	Size class (mm standard length)							
	<30	30–50	50–75	75–100	100–150	150–250	>250	Total
				Spotted seatrout				
Jan	0	0	1	2	2	1	0	6
Mar	1	0	0	1	1	3	0	6
May	8	12	2	0	2	2	0	26
Jun	12	19	5	3	1	0	1	41
Jul	11	4	2	1	1	0	0	19
Sep	3	4	12	4	2	2	0	27
Nov	3	8	4	2	2	0	0	19
Grassflats	36	42	24	12	10	7	0	131
Channels	2	4	0	0	1	1	1	9
Mangroves	0	1	2	1	0	0	0	4
Totals	38	47	26	13	11	8	1	144
				Gray snapper				
							0	
Jan	0	1	5	2	2	2	0	12
Mar	0	1	16	11	3	0	0	31
May	0	0	14	30	7	6	0	57
Jun	0	1	1	16	16	7	1	42
Jul	0	0	0	1	4	2	0	7
Sep	6	2	9	0	10	9	2	38
Nov	0	3	9	4	3	9	0	28
Grassflats	3	5	21	46	26	14	0	115
Channels	2	1	28	13	14	10	0	68
Mangroves	1	2	5	5	5	11	3	32
Totals	6	8	54	64	45	35	3	215

carideans, and fish. Overall, most of the trout captured had recently fed and 20% had empty stomachs. Eighteen percent of the trout from flats had empty stomachs, whereas 56% of the trout from channels were empty. An increasingly larger proportion of trout had empty stomachs as their size increased, probably related to a decrease in feeding frequency with increasing size.

The single most important food for trout above 30 mm from seagrass habitats was penaeid shrimp (Fig. 2). Trout less than 30 mm from grass beds consumed in the same proportions amphipods (*Gammarus* spp.), mysids (not identified), and carideans (most frequently, *Periclimenes* sp. and *Tozeuma carolinensis*). Copepods and fish percent frequency of occurrence was slightly less than these three groups and decapod zoea/megalopa occurred in only 5% of the stomachs of fish in this size class. One 0.3 g trout contained at least 150 copepods. Fish, primarily rainwater killifish (*Lucania parva*) increased in frequency of occurrence as trout reached 50 mm, after which they contributed to about one-third of the diet. Other identifiable fishes found in trout were gulf toadfish (*Opsanus beta*), inshore lizardfish (*Synodus foetens*), bay anchovy (*Anchoa mitchilli*), hardhead silverside (*Atherinomorus stipes*), pipefish (*Syngnathus* sp.), silver jenny (*Eucinostomus gula*), goldspotted killifish (*Floridichthys carpio*), code goby (*Gobiosoma robustum*), and spotted seatrout.

Variations in the food habits of spotted seatrout as reported in the literature indicate that the geographic location and type of estuary influences available prey

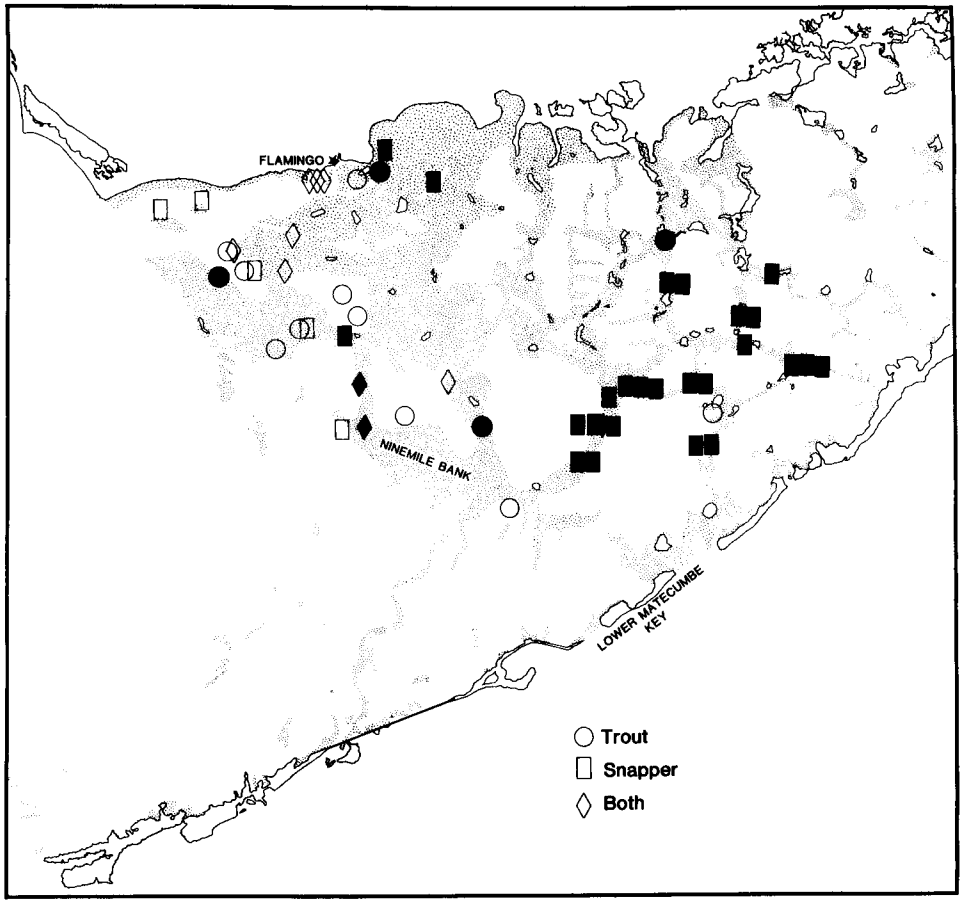
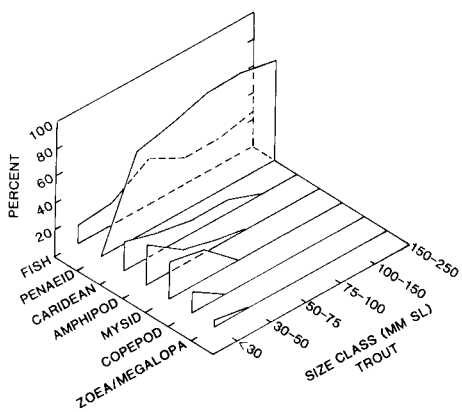


Figure 1. Distribution of collections of spotted seatrout and gray snapper in Florida Bay. Dark symbols represent channel stations.

and that trout stomach contents reflect this availability (Table 2) (Moody, 1950; Darnell, 1958; Tabb, 1961; Carr and Adams, 1973; Overstreet and Heard, 1982; Rutherford et al., 1982). Moody (1950) found that caridean and penaeid shrimp were dominant in Cedar Key spotted seatrout diets, while Darnell (1958) found that trout in Lake Pontchatrain, a habitat characterized by low salinity, high turbidity and sparse seagrass beds, fed more on mysids, benthic amphipods, "larval" fish, and anchovies. Both visibility and prey availability as influenced by water circulation, sediment type and vegetation probably influences prey type as well as feeding habits.

The suggestion of Tabb (1961) that stomach contents might represent the seasonal variability of prey was assessed by comparing the percent frequency of occurrence of food groups found in two size classes combined (30–75 mm SL) for each month sampled (Fig. 3). Mysids were highest in May, amphipods and carideans were highest in June, pink shrimp were lowest in May, but generally high the rest of the year, and fish were highest in July. Dietary shifts may coincide with variations in prey abundance, i.e., penaeid shrimp. Pink shrimp, *Penaeus duorarum,* abundance was observed to be maximum in January and March (Thayer



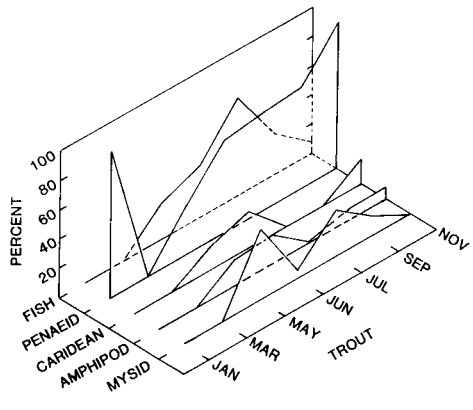


Figure 2 (Left). Percent frequency of occurrence of food in 107 stomachs with food from spotted seatrout collected on grassflats.

Figure 3 (Right). Percent frequency of occurrence of food in 61 stomachs with food from 30–75 mm spotted seatrout collected during the year from all habitats. No fish were collected in March.

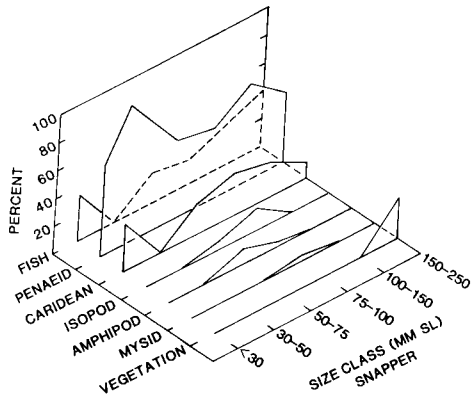
et al., 1987b), with shrimp total lengths averaging 50–70 mm. Seasonal trends in numbers of fish were evident at two sites sampled regularly during the primary study. Numbers of fish were highest from May through September and lowest in November through March (Thayer et al., 1987b). Only one trout was caught in the 30–75 mm size in January and March of the 61 fish in this size group containing food, which precludes an analysis of a possible shift in feeding on shrimp in the winter to fish in the summer.

Gray Snapper Stomach Contents.—The relative proportion of empty stomachs of snapper in grass beds and channels was almost identical with trout. Three times as many specimens (60% vs. 21%) had no food when collected in channels as compared to those collected in grass flats. Channels may serve as a daytime refuge rather than as a feeding ground. This is similar to a function of coral reefs where many fishes hide and rest during the day and then forage on adjacent grass beds at night (Ogden and Ehrlich, 1977). In mangroves, 31% had empty stomachs.

Table 2. Frequency of occurrence (percent) of food groups in stomachs of juvenile (<200 mm) spotted seatrout reported for areas along the southern coast of the U.S.

	Frequency of occurrence (%)					
Food group	Florida Bay, FL (Hettler, this study)	Mississippi Sound, MS (Overstreet and Heard, 1982)	Cedar Key, FL (Moody, 1950)	Crystal River, FL (Carr and Adams, 1973)	Everglades N.P., FL (Rutherford et al., 1982)	Indian River, FL (Tabb, 1961)
Penaeids	47	*	35	†	90	54
Fishes	22	65	41	59	22	4
Mysids	16	*	0	5	0	43
Amphipods	15	*	0	2	0	0
Carideans	14	*	22	†	0	0
Copepods	5	0	6	2	0	0
Isopods	0	*	0	0	0	0
Polychaetes	0	2	0	0	0	0
Molluscs	0	2	0	2	8	0
Vegetation	0	3	0	<1	12	0

* These groups together found in 47% of the stomachs.
† These groups together found in 36% of the stomachs.



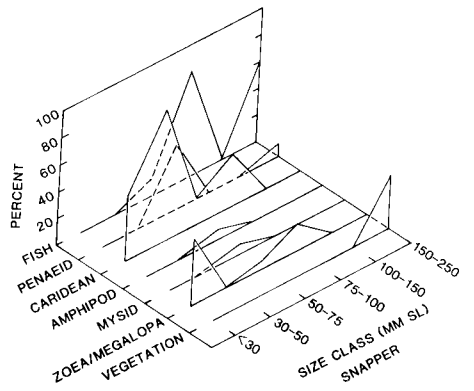


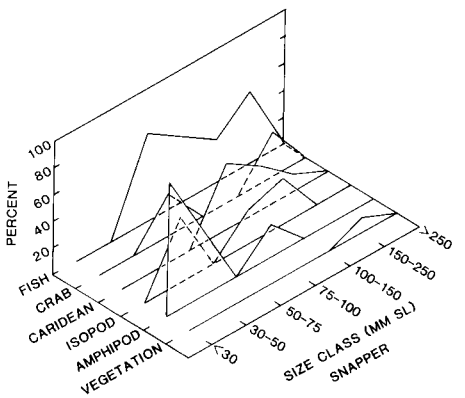
Figure 4 (Left). Percent frequency of occurrence of food in 91 stomachs with food from gray snapper collected in grass beds.

Figure 5 (Right). Percent frequency of occurrence of food in 27 stomachs with food from gray snapper collected in channels.

Penaeid shrimp dominated the diets of all size classes of snapper collected on grass flats, contributing overall to 59% of the frequency of occurrence compared with 24% for carideans and fish, respectively (Fig. 4). Pink shrimp are the dominant large invertebrate in the Florida Bay seagrass meadow/carbonate mud bank habitat (Tabb et al., 1962). The food of snapper in grass beds was similar to trout, except that snapper also ate isopods and vegetation, but did not contain decapod zoea/megalopa or copepods. Vegetation, identified as *Thalassia,* was only found in a few specimens, all over 150 mm. Among snappers taken from channels with non-empty stomachs, the frequency of occurrence was similar for fish, penaeids and carideans (Fig. 5). In mangroves, fish contributed up to 45% of the stomach contents for all size classes (Fig. 6). No penaeid shrimp were found in mangrove specimens, just as they were not found in the few trout collected in mangroves. Penaeid shrimp were rarely collected or observed in the mangrove habitat, although they were common in adjacent seagrass habitats sampled by trawl (Thayer et al., 1987a). Rainwater killifish and pipefish were identified in snapper stomachs from mangroves, while snapper from seagrass beds contained gulf toadfish, gobies (primarily the code goby), seahorse (*Hippocampus* spp.), and silver jenny.

Over a seasonal cycle penaeids became important in 30–75 mm snapper in May and peaked in November, fish were most frequently found in June, and all other food groups were numerous in the cooler months (Fig. 7). Rutherford et al. (1983) reported for snapper stomachs that shrimp were most frequent from September to November when compared to their frequency of occurrence in other seasons, crabs were most frequent March to May, fish were most frequent June to August, and amphipods were most frequent December to January.

The food habits observed in this study are not different than habits reported earlier by Starck and Schroeder (1970) on gray snapper collected from grass beds, coral reefs and near mangroves in the Florida Keys near Lower Matecumbe Key. Small juveniles collected in grass beds consumed crustaceans (93%), primarily amphipods and caridean shrimp, while larger juveniles collected near mangroves and seagrass also consumed crustaceans (69%), primarily pink shrimp and xanthid crabs. Starck and Schroeder (1970) found a high incidence (52%) of empty stomachs and thought that juvenile snapper in grass beds fed during the day and larger



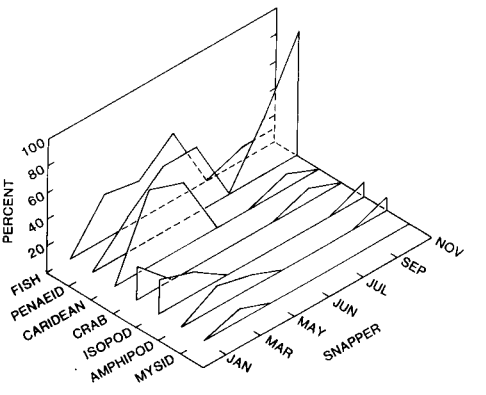


Figure 6 (Left). Percent frequency of occurrence of food in 22 stomachs with food from gray snapper collected in mangroves.

Figure 7 (Right). Percent frequency of occurrence of food in 41 stomachs with food from 30–75 mm gray snapper collected during the year from all habitats. No fish were collected in July.

snapper, >75 mm SL, fed at night as stomachs of these fish collected in the later afternoon were generally empty. He recommended that the best time to collect snapper for food habits studies was in the early morning when stomachs are fullest.

Management Implications.—Juvenile spotted seatrout and gray snapper are opportunistic carnivores occurring in similar habitats in Florida Bay throughout the year and feed almost exclusively on crustaceans and fish, the principal natant occupants of Florida Bay. Both species fed on mysids, amphipods, carideans, penaeids, and fishes, shifting to these last two groups as they grew into large juveniles. Grassbeds appear to be the most important feeding habitat. Penaeid shrimp were most important to both species in shallow grass flats, but were not observed in stomachs of fish from mangrove prop root habitats. No unique prey species were identified as dietary components that are not common inhabitants of Florida Bay. This suggests that these species are not species-specific food limited. Abundant stocks of juvenile penaeid shrimp appear important in supporting large populations of juvenile spotted seatrout and gray snapper.

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